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ACE3P for RF Simulation

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What is ACE3P?

SLAC has developed an RF simulation suite that's worth having in your toolkit.

- Finite element code for RF structure design
- Parallel code runs large problems quickly on NERSC
- Meshing with $>$ 1st order tetrahedra for high geometry fidelity
- Suite of programs includes (ADMX-relevant in boldface):
  - **Omega3P** (eigenmode solver)
  - **S3P** (scattering parameters)
  - `T3P` (time-domain)
  - `Track3P` (particle tracking for multipacting, dark current)
  - `Pic3P` (particle-in-cell)
  - **TEM3P** (multiphysics)
  - Plus more under development.

For more details:

K. Ko, et al., "Advances in parallel electromagnetic codes for accelerator science and development", LINAC2010, Tsukuba, Japan, 2010.

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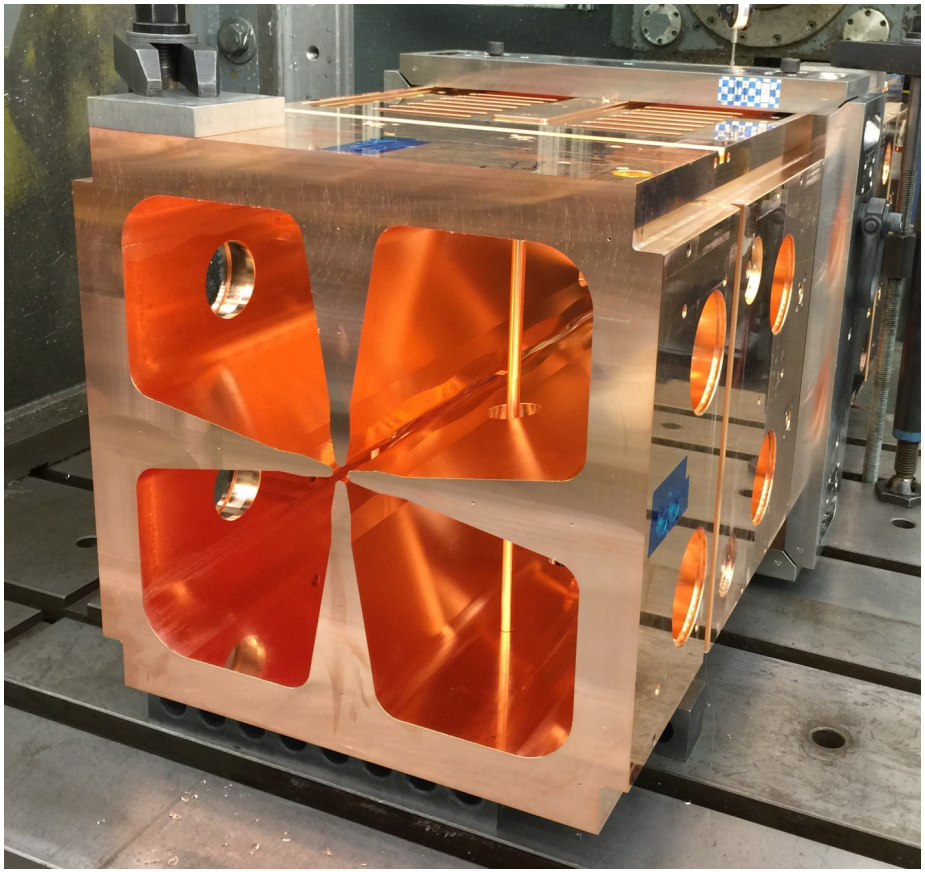
Quick example: Eigenmode simulation of Fermilab's PXIE RF Quadrupole



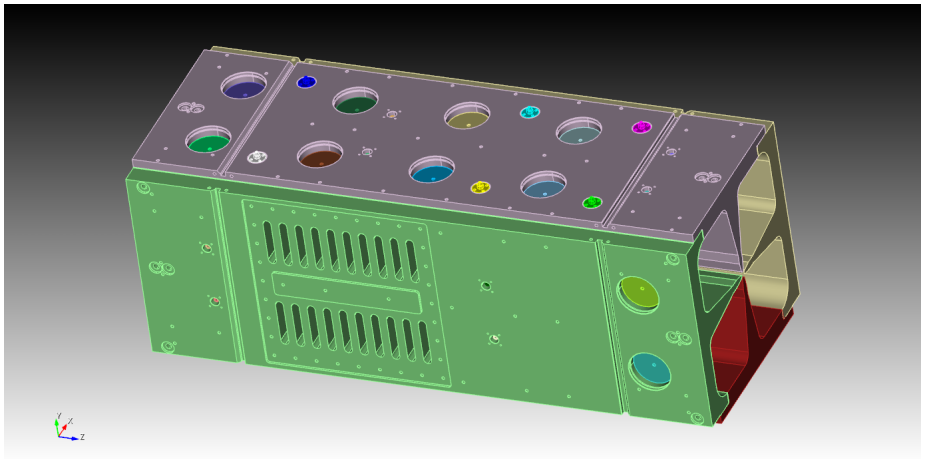
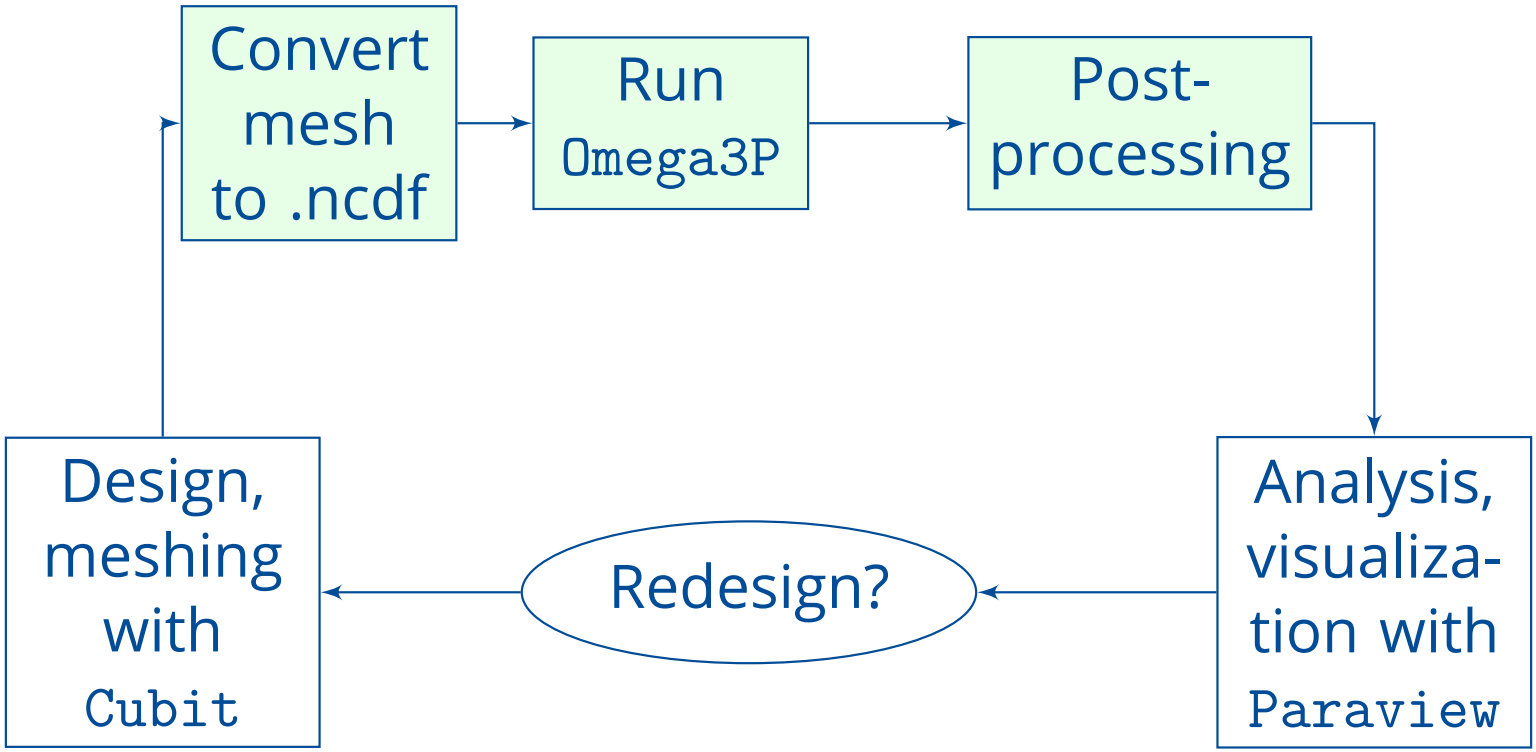


Figure : Fully-featured CAD model.

ACE3P works differently from other RF codes. Here is a generalized Omega3P workflow.

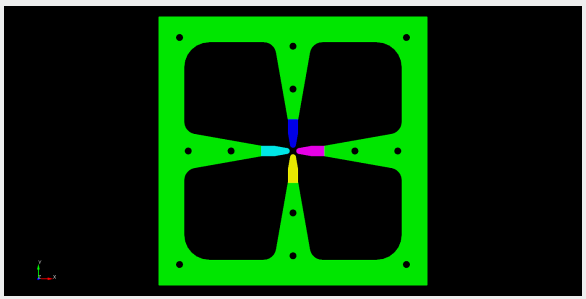


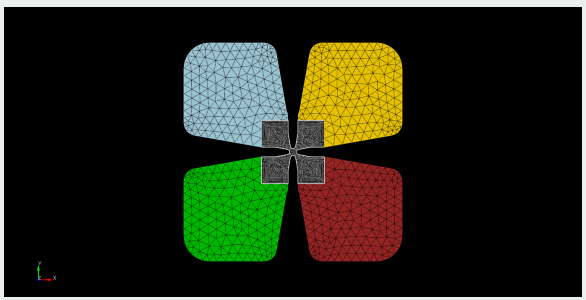
Processes in green boxes run on NERSC.

Meshing with Cubit

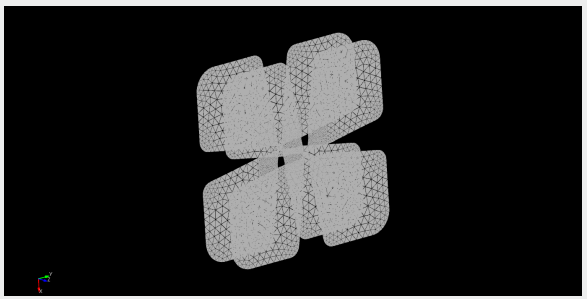
- Developed by Sandia National Lab
- Runs on your local machine
- GUI or script-based design

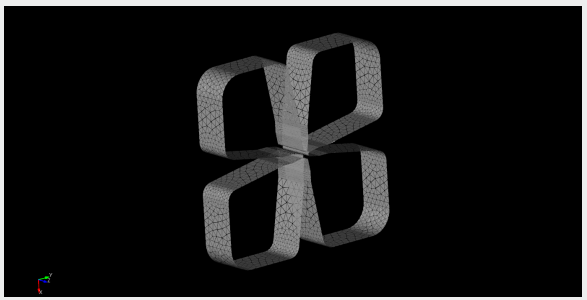
Define geometry & mesh





Set boundary conditions





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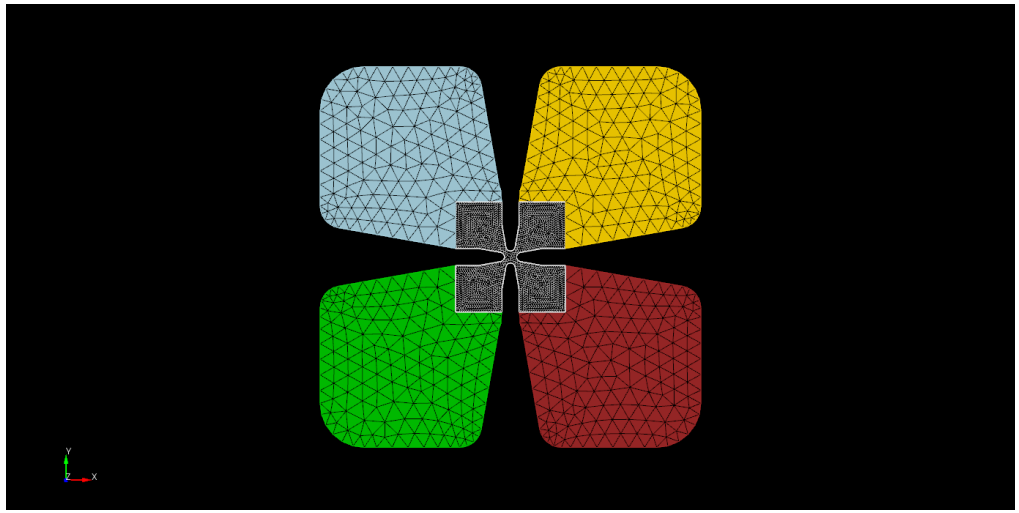
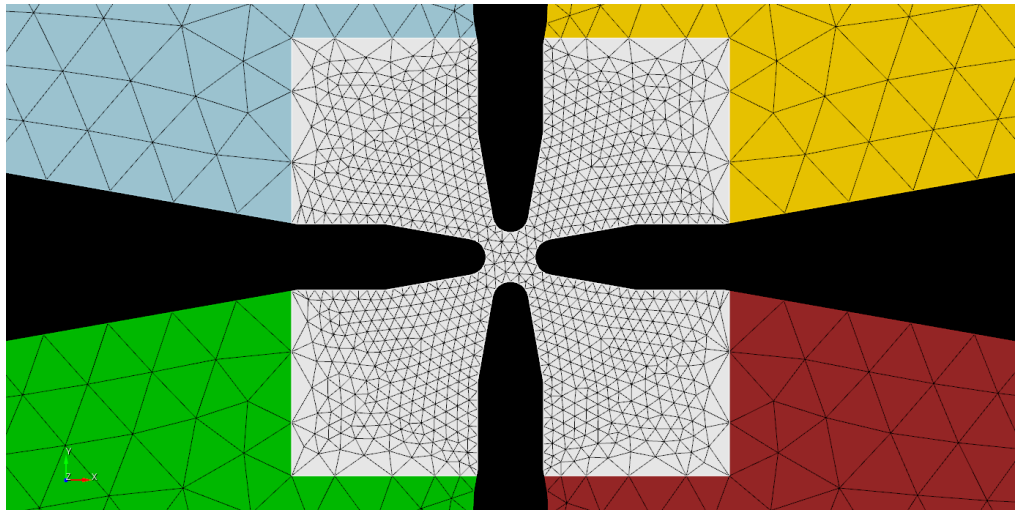
Meshing with Cubit, cont'd.





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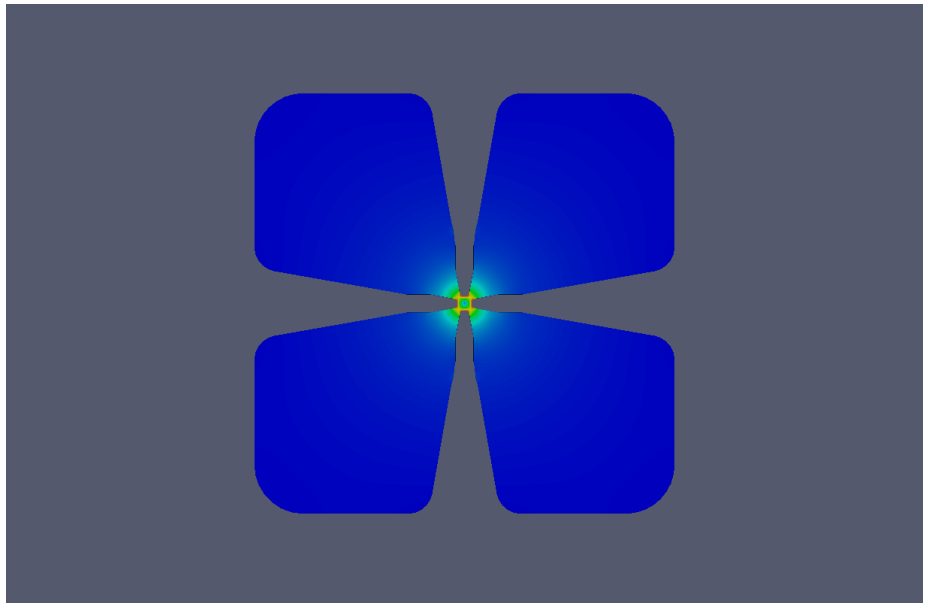
Run Omega3P



- Frequency, Q, other RF parameters given in a logfile when job exits.
- Postprocess for more detailed calculations (R/Q, fields on a surface, etc.)
- For Omega3P, output includes a mode file that can be viewed in Paraview.

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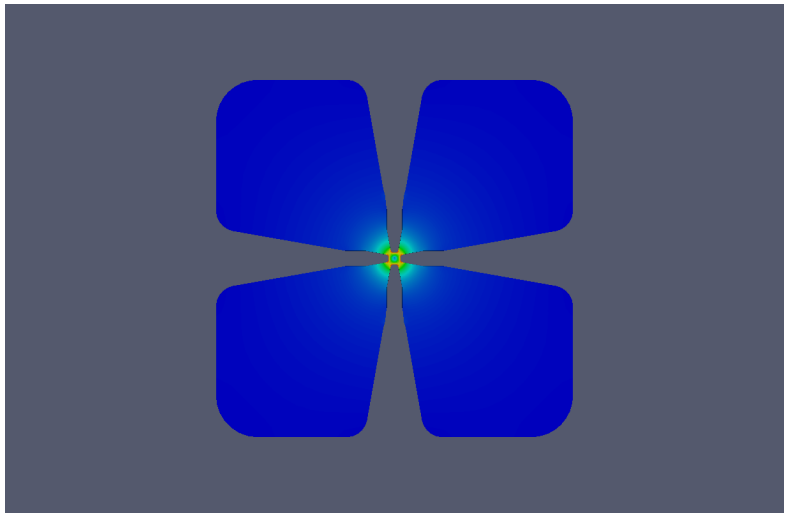
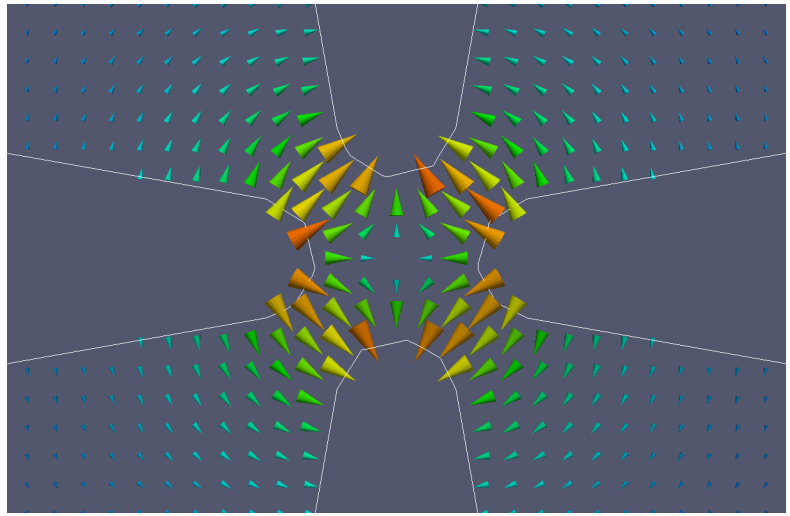
Visualize in Paraview





Next steps

- These fields can be used in further calculations.
- Track3P: Use this solution to study dark current, resonant electron behavior.
- TEM3P: Use this solution to study detuning from thermal effects, etc.

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2. Thermal effects on cavity tuning via TEM3P.

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- Requires Cubit, Paraview. (Benefit?)

For more information:

- ACE3P website:

  https://confluence.slac.stanford.edu/display/AdvComp/ACE3P+-+Advanced+Computational+Electromagnetic+Simulation+Suite

- CW14 code workshop materials:

  https://portal.slac.stanford.edu/sites/conf_public/cw14/Pages/default.aspx

- Some interesting papers:
  - http://accelconf.web.cern.ch/accelconf/IPAC2014/papers/wepri067.pdf
  - http://scitation.aip.org/content/aip/proceeding/aipcp/10.1063/1.4773807
  - http://www-public.slac.stanford.edu/SciDoc/docMeta.aspx?slacPubNumber=slac-pub-15757

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  - http://scitation.aip.org/content/aip/proceeding/aipcp/10.1063/1.4773807
  - http://www-public.slac.stanford.edu/SciDoc/docMeta.aspx?slacPubNumber=slac-pub-15757

- **Thanks for your attention!**